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Indian Standard

SPECIFICATION FOR NET PYRRADIOMETER

UDC 535·214·4:550·835

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NEW DELHI 110002

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AMENDMENT NO. 2 JANUARY 1987

TO

IS:8693-1978 SPECIFICATION FOR NET PYRRADIOMETER

(*Page 8, clause 6.3.3, line 2*) - Substitute '30 mm/h' *for* '25 mm/h'.

(*Page 9, clause 6.4.2, line 3*) - Substitute '30 mm/h' *for* '25 mm/h'.

(*Page 9, clause 6.4.4, line 4*) - Substitute '30 mm/h' *for* '25 mm/h'.

(EDC 69)

Reprography Unit, ISI, New Delhi, India

AMENDMENT NO. 1 MAY 1985

TO

IS:8693-1978 SPECIFICATION FOR NET PYRRADIOMETER

(*Page 3, clause 2.1, line 6*) - Substitute the word 'even' after the word 'shape'.

(*Page 7, clause 6.1.5, lines 1 and 2*) - Substitute '± 3 W_{m}-2' *for* '± 0.3 mW/cm^{2}' and '28 to 30 µV/W_{m}-2' *for* '20 ± 1 mV/cal/cm^{2}/min'.

[*Page 11, clause 8.1.2*(b)] - Substitute 'µV/W_{m}-2' *for* 'mV/cal/cm^{2}/min'.

(EDC 69)

Reprography Unit, ISI, New Delhi, India

Indian Standard

SPECIFICATION FOR NET PYRRADIOMETER

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Indian Standard
SPECIFICATION FOR NET PYRRADIOMETER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 31 January 1978, after the draft finalized by the Meteorological Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 The different radiation fluxes to and from the earth's surface are amongst the most important components in the heat budget of the earth as a whole and of any individual place at the earth's surface or in the atmosphere. Measurements of these fluxes are of great value in meteorology and in the studies of the exchange and transformation of energy in the earth-atmosphere system, in the study of the distribution and the variations of incoming, outgoing and net radiation, and in meeting the requirements of biological, medical, agricultural, architectural and industrial activities.

0.3 The exact knowledge of the net radiation, that is, the difference between the incoming and outgoing radiation irrespective of wave length is of great importance not only in meteorology, but also in agriculture, hydrology, building research, air conditioning and any application where a radiative energy budget is needed.

0.4 The principal instrument for the measurement of the net flux of downward and upward total (solar, terrestrial surface and atmospheric) radiations through a horizontal surface is the net pyrradiometer using a thermopile as the sensitive element.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS:2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the general requirements for a shielded net pyrradiometer with mounting and suitable recorder with charts for use with it.

---

*Rules for rounding off numerical values (*revised*).

2. DESCRIPTION

2.1 The instrument consists essentially of an accurate thermopile of 120 junctions between copper and constantan, encapsulated between radiation absorbent black sensor plates. The complete assembly is shielded from weather by wide band transmittance polyethylene hemisphere. The polyethylene hemispheres are kept inflated by dry air to preserve wrinkle free and accurate spherical shape in high winds. The air supply to the hemispheres can be either from a pressurized cylinder or from a low capacity compressor pump.

2.2 The radiometer head is connected to a long shaft through which the electrical leads as well as the air inlet and outlet tubes pass. The shaft also serves for fixing the radiometer to a portable or permanent mounting. The generated electromotive force which is linearly proportional to the difference in radiation falling on the top and bottom sensor plates is conveyed through a shielded cable and a weather-proof plug inserted at the end of the shaft to a suitable millivoltmeter having the desired range and accuracy.

3. TYPE

3.1 The net pyrradiometer shall be of the type indicated in Fig. 1.

4. MATERIAL

4.1 The radiometer head shall be made of phenol based laminate.

4.2 The sensitive element shall be 0·19 mm thick constantan wire half portion of which is plated with copper and wound over a square clear acrylic former as shown in Fig. 2.

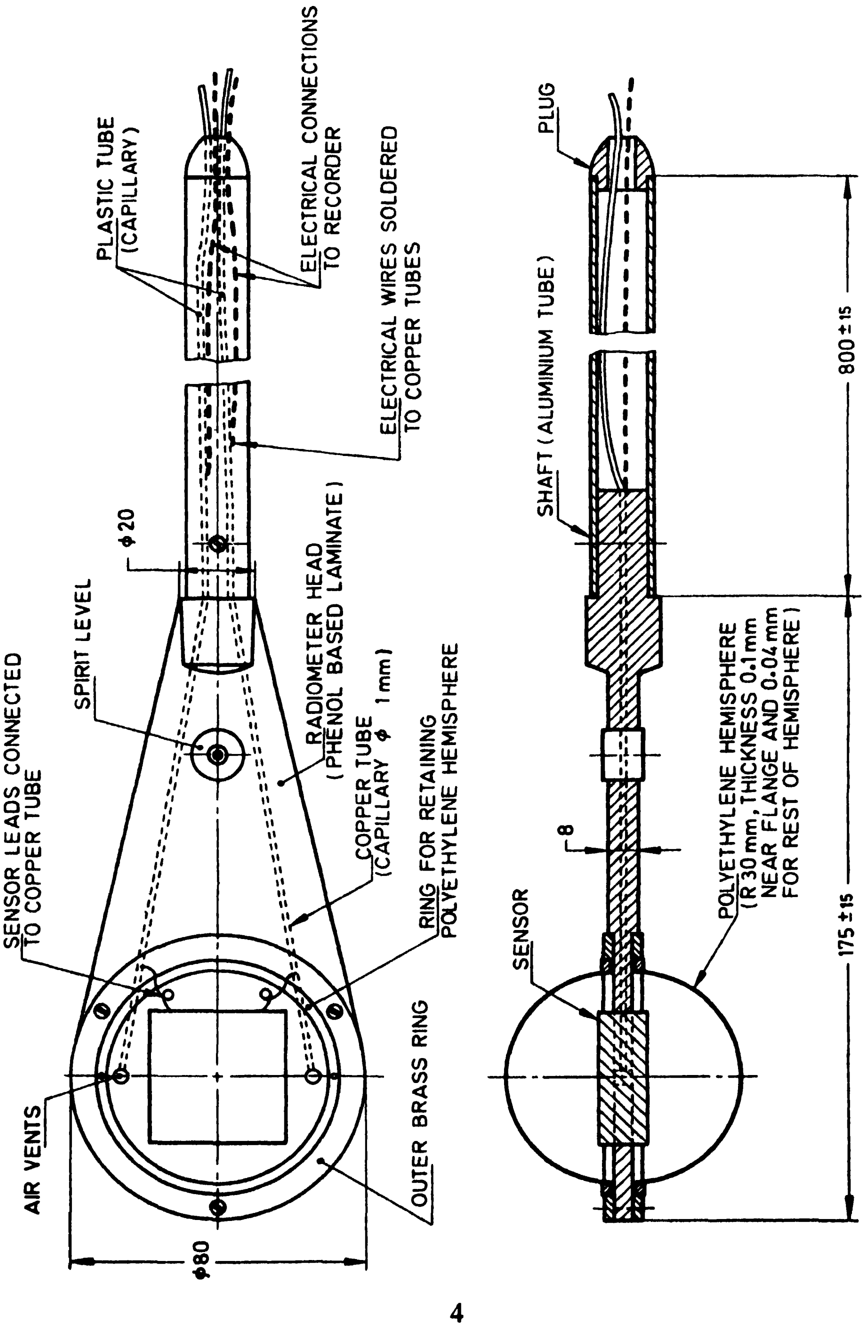
4.3 The protective hemispheres shall be made from thin polyethylene film of thickness 0·1 mm such that the thickness of hemisphere is 0·04±0·01 mm except at and near the flange.

4.4 The shaft shall be anodized aluminium tube of 13 mm bore and approximately 800 mm long.

4.5 The other parts like hemisphere retaining rings, and the outer rings shall be made of brass.

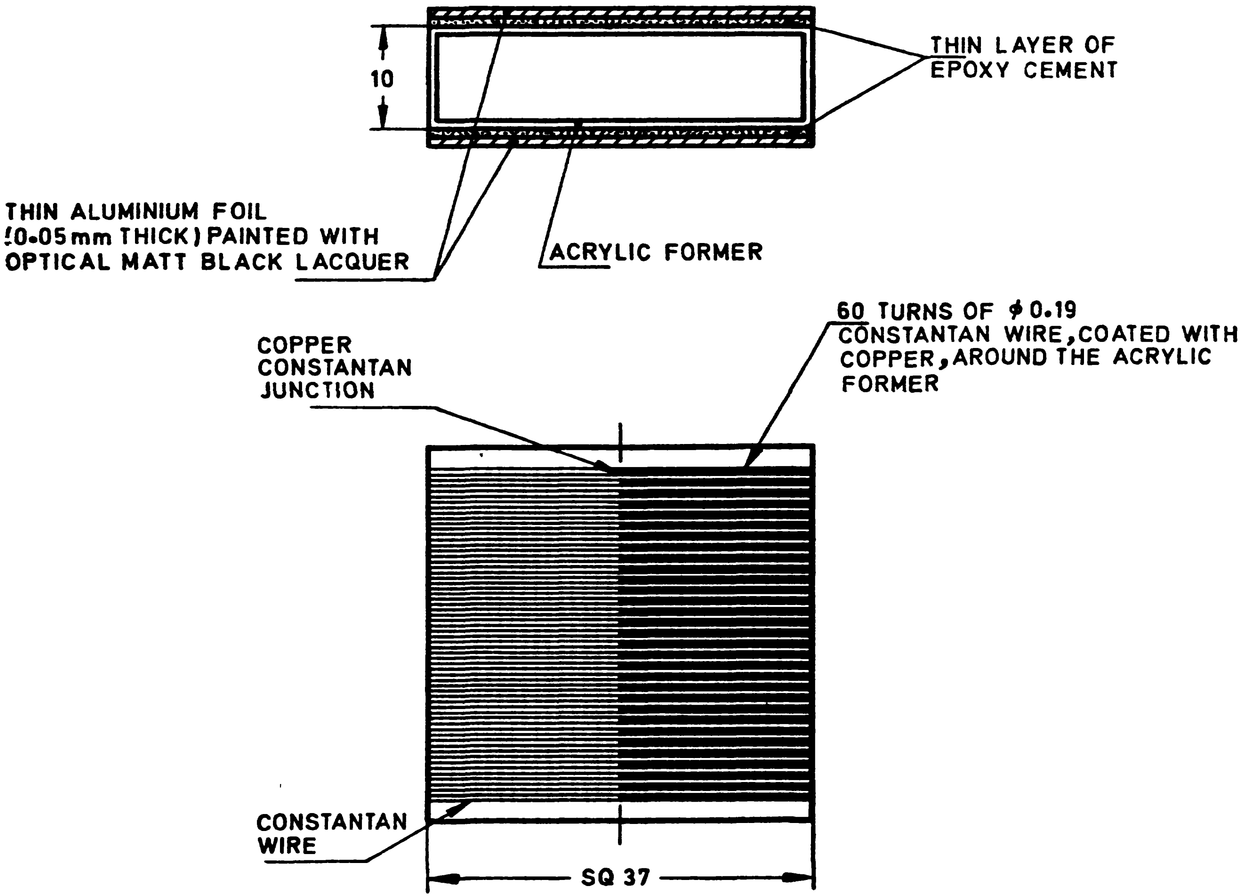
5. DIMENSIONS

5.1 The instrument shall have the dimensions indicated in Table 1 and Fig. 1 and 2.


AIR VENTS
SENSOR LEADS CONNECTED TO COPPER TUBE
SPIRIT LEVEL
RADIOMETER HEAD (PHENOL BASED LAMINATE)
COPPER TUBE (CAPILLARY ϕ 1 mm)
RING FOR RETAINING POLYETHYLENE HEMISPHERE
OUTER BRASS RING
ϕ80
ϕ20
PLASTIC TUBE (CAPILLARY)
ELECTRICAL CONNECTIONS TO RECORDER
ELECTRICAL WIRES SOLDERED TO COPPER TUBES
PLUG
SHAFT (ALUMINIUM TUBE)
SENSOR
8
POLYETHYLENE HEMISPHERE (R 30 mm, THICKNESS 0.1 mm NEAR FLANGE AND 0.04 mm FOR REST OF HEMISPHERE)
175 ± 15
800 ± 15

All dimensions in millimetres

FIG. 1 NOMENCLATURE AND DIMENSIONS FOR NET PYRRADIOMETER


THIN LAYER OF EPOXY CEMENT
10
THIN ALUMINIUM FOIL (0.05 mm THICK) PAINTED WITH OPTICAL MATT BLACK LACQUER
ACRYLIC FORMER
60 TURNS OF ϕ 0.19 CONSTANTAN WIRE, COATED WITH COPPER, AROUND THE ACRYLIC FORMER
COPPER CONSTANTAN JUNCTION
CONSTANTAN WIRE
SQ 37

All dimensions in millimetres.

FIG. 2 THERMOPILE SENSOR OF NET PYRRADIOMETER

TABLE 1 MAIN DIMENSIONS OF NET PYRRADIOMETER

(*Clause* 5.1)

SL No.	COMPONENT	DIMENSIONS, mm
(1)	(2)	(3)
i)	Sensor	37 × 37 × 10
ii)	Overall length of head	175 ± 15
iii)	Maximum diameter of head	80
iv)	Shaft (aluminium tube)	≈800 × 13 bore
v)	Diameter of polyethylene hemispheres	60
vi)	Hemisphere retaining rings	60 ID × 66 OD × 3 thick
vii)	Outer brass rings	66 ID × 80 OD × 3 thick
viii)	Thickness of constantan wire	0·19
ix)	Thickness of polyethylene film	0·1
x)	Overall length of instrument	1 000 ± 5

6. DETAILED REQUIREMENTS

6.1 Pyrradiometer Head

6.1.1 The head shall be of the shape and dimensions shown in Fig. 1. It shall be made from phenolic based laminate, two laminates of suitable shape and dimensions being cemented together with two copper tubes in between them running along the length of the head.

6.1.2 The sensitive element shall consist of 60 thermojunctions on each side, the junctions being between copper and constantan. The constantan wire shall be wound on a clear acrylic former and one half of each turn shall be plated with copper. The former shall be securely fitted tight into the head in such a way that the individual turns do not touch and short each other. The two free ends of the wire shall be soldered to the two copper tubes.

6.1.3 The junctions of the thermopile shall lie on an even horizontal plane and both the top and bottom surfaces shall be cemented to a thin aluminium foil using a thin layer of epoxy resin cement. The aluminium foil shall be painted black with special optical black lacquer.

6.1.4 The absorptivity of the black lacquer shall not be less than 98 percent and uniform over a wide range of wave lengths.

6.1.5 The sensitivity of the instrument shall be ±0·3 mW/cm^2 and the output 20±1 mV/cal/cm^2/min. The total resistance with the connecting leads shall be 80±5 ohms.

6.1.6 The calibration factor shall not vary by more than ±2 percent per year.

6.1.7 The maximum error due to variation in ambient temperature shall not exceed ±2 percent.

6.1.8 The maximum error caused by a departure from the assumed spectral response of the receiving surface shall not exceed ±3 percent.

6.1.9 The maximum error due to non-linearity of the response of the instrument shall not exceed ±2 percent.

6.1.10 The time constant of the instrument, that is, the time necessary for it to register 98 percent of a sudden change in radiation shall not exceed 60 seconds.

6.1.11 The cosine response and the azimuth response, that is, the deviation of the directional response of the receiver from that assumed shall be within ±5 percent.

6.1.12 The surfaces of the outer ring, the hemisphere retaining ring and the blackened aluminium foil shall all lie on the same horizontal plane.

6.1.13 The two outer rings of brass shall be fitted to the head of the instrument by means of screws. The inner edge of the brass ring shall be threaded to take the retaining ring for the polyethylene hemisphere.

6.1.14 Two holes shall be drilled through the head just at the place where the copper tubes end, so that air can freely pass in and out of the polyethylene hemispheres.

6.1.15 The polyethylene hemispherical shields shall have a diameter of 60 mm and a flange of 3 mm. They shall sit snugly below their retaining rings without obstructing the air vents. There shall be a soft rubber ring washer below the flange of the polyethylene hemisphere so that when the retaining rings are tightened, the two hemispheres are air-tight.

6.1.16 The narrow end of the head shall be finished to a cylindrical shape with the ends of the copper tubes projecting out. An anodized aluminium tube shall be fixed over the cylindrical portion by means of screws. Two plastic covered electrical lead wires shall be soldered to the two copper tubes about a centimetre from the free ends and two plastic tubes shall be fitted over the free ends of the copper tubes ensuring there is no possibility of electrical leakage. Both the pairs of wires and tubes shall be inserted inside a plastic sleeving, running along the inside length of the aluminium shaft and projecting out of a weather-proof plastic bushing at the end of the aluminium shaft.

6.1.17 The two electrical lead wires from the sensor shall be connected to the recorder and one of the two plastic tubes to a low capacity compressor pump or a pressurized air cylinder through a needle valve and drying agent. The other plastic tube shall act as the air outlet and dip into a receptacle containing water and an outlet tube.

6.1.18 The sensitive head shall be provided with spirit level (*see* IS:5706-1970*) at a place shown in Fig. 1.

6.2 Mounting

6.2.1 The instrument shall be provided with either a portable or permanent mounting as required by the user.

6.2.2 The portable mounting shall be of such a type that the sensor may be exposed truely horizontally at a height of about 1·4 m above the ground. A triped stand with adjustable legs and provided with a circular clip at top into which the shaft of the instrument may be inserted and clamped, is found to be adequate. Any other type of mounting which enables installation of the instrument in a truely horizontal plane and whose mount itself does not form an obstruction shall also be acceptable.

6.2.3 The permanent mounting shall also enable the instrument to be installed permanently at the desired height of 1·4 m above the ground. The mounting shall be of any convenient type like a sturdy angle iron fixed in concrete in the ground and provided with an 'L' bent at top on which the shaft of the instrument may be placed and clamped firmly.

6.2.4 Either type of mounting shall be sturdy enough to prevent deviation from its true horizontal position under operating conditions specified by the user.

6.3 Recorder

6.3.1 The recorder shall be of potentiometric type and be provided with an arrangement which gives a continuous record on a roll chart.

6.3.2 The method of recording shall be through a capillary pen writing with ink on paper.

6.3.3 The chart drive of the recorder shall be operated by an electrically driven motor. The chart speed shall be at least 25 mm/h. Provision shall be made for varying the chart speed up to 150 mm/h.

6.3.4 The recorder shall have a range from −5 through 0 to +20 mV and an accuracy of ±1 percent. It shall have a threshold sensitivity of ±0·1 percent.

6.3.5 The recorder shall be provided with means to shift and adjust the position of its zero.

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*Specification for spirit levels for use in precision engineering.

6.3.6 The measuring circuit of the recorder shall have the temperature co-efficient as near to zero as possible and the total errors of the recording apparatus shall not exceed ±1 percent.

6.4 Recorder Chart

6.4.1 The chart shall be of the roll type suitable for the recorder.

6.4.2 The chart shall be designated RP1, the designation shall be written in the corner of the chart and shall be repeated at intervals of every metre and be of the type shown in Fig. 3 for 25 mm/h speed.

6.4.3 It shall have a minimum length of 30 m and a minimum graduated width of 160 mm. The overall width of the roll chart shall not be less than 180 mm.

6.4.4 The chart shall be divided along its length into 100 equal divisions with every fifth division slightly thickened and every tenth division more prominently thickened. It shall have printed on it vertical lines corresponding to hours, the time scale being equal to 25 mm/h. Each hour line shall appropriately be figured from 0 to 24. The lines shall be figured at intervals of 20 divisions, the set of figures being spaced 200 mm apart.

6.4.5 The chart shall be printed on thin white paper on which the recording ink shall not spread or show tendency to feather.

7. WORKMANSHIP AND FINISH

7.1 The polyethylene hemispheres of the net pyrradiometer shall be smooth and free from wrinkles.

7.2 The complete instrument in the final stage of assembly shall satisfy the requirements given in **6.1**. The external surface shall have smooth and permanent finish.

7.3 Special care shall be given to make the interior of the two hemispheres air tight and dry to ensure longivity and sensitivity of the sensing element. It shall be ensured that moisture does not reach the leads from the thermopile.

7.4 The electrical connections shall be made neatly using minimum amount of solder while at the same time ensuring strength and permanence of contact. The electrical junctions shall be suitably protected by glass fibre sleevings and wax coating, to prevent malfunctioning of the electrical circuit due to high humidity and presence of water vapour.

7.5 The entire head of the instrument, except the sensing element and the motal rings, shall be painted white with two coats of good quality enamel paint (*see* IS:2932-1964*) over a coat of primer (*see* IS:2074-1962†).

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*Enamel, synthetic, exterior, Type I, (a) undercoating, (b) finishing colour as required.

†Ready mixed paint, red oxide-zinc chrome, priming.

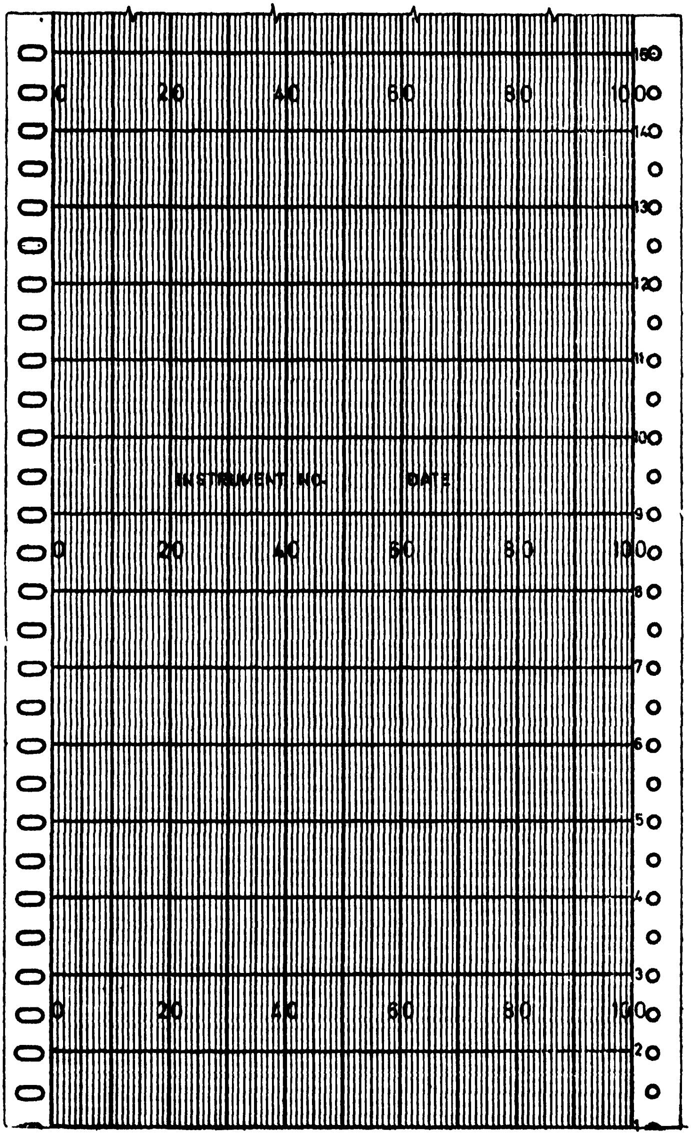

FIG. 3 RECORDER CHART No. RP1

7.6 The metal rings shall be highly polished to reduce the absorption of radiation. The shaft of the pyrradiometer shall be anodized dull white.

8. MARKING AND PACKING

8.1 Marking

8.1.1 Each net pyrradiometer shall have the following neatly and legibly engraved on a plate fixed to the head of the instrument.

a) 'NET PYRRADIOMETER';

b) Manufacturer's name or trade-mark, if any; and

c) Serial number and year of manufacture.

8.1.2 The equipment shall also be provided with a card giving the following information:

a) The total resistance of the thermopile and the lead wires;

b) The output of the instrument in $mV/cal/cm^2/min$; and

c) Range and accuracy of the potentiometric recorder.

8.1.3 The instrument and recorder may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8.2 Packing

8.2.1 The pyrradiometer, its mount, the dry air supply unit and the recorder shall be suitably packed separately as agreed between the purchaser and the manufacturer. Each instrument set shall be supplied with sufficient quantity of suitable chart rolls and ink to last at least for 12 months.

9. INSPECTION

9.1 Each pyrradiometer and its accessories including the recorder shall be inspected individually for conformity to all the requirements of this specification.

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